

## Environmental Effects of Cured-in-Place Pipe Repairs

*Requested by*

Sean Penders, Design

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*The Caltrans Division of Research and Innovation (DRI) receives and evaluates numerous research problem statements for funding every year. DRI conducts Preliminary Investigations on these problem statements to better scope and prioritize the proposed research in light of existing credible work on the topics nationally and internationally. Online and print sources for Preliminary Investigations include the National Cooperative Highway Research Program (NCHRP) and other Transportation Research Board (TRB) programs, the American Association of State Highway and Transportation Officials (AASHTO), the research and practices of other transportation agencies, and related academic and industry research. The views and conclusions in cited works, while generally peer reviewed or published by authoritative sources, may not be accepted without qualification by all experts in the field.*

## **Executive Summary**

### **Background**

To rehabilitate culverts without disrupting highway corridors and causing long delays and significant added costs, Caltrans will need to use cured-in-place pipe (CIPP) repairs, a method of completely relining culverts using a thermosetting, resin-impregnated flexible tube that is inflated and cured with hot water or steam.

The North Coast Regional Water Quality Board (NCRWQB) is currently not permitting use of CIPP because of concerns that it negatively affects water quality. These concerns are based predominantly on a study by the Virginia Department of Transportation (DOT), which showed that CIPP sometimes caused residual styrene concentrations in the stormwater that were above the U.S. Environmental Protection Agency's maximum contaminant level for drinking water, and led to a moratorium on the use of CIPP in Virginia. However, subsequent Virginia DOT studies showed that the release of styrene was caused by poor CIPP installation practices, and implementing new specifications could eliminate these problems. With the new specifications in place, Virginia DOT has resumed its use of CIPP, and Caltrans has revised its CIPP specifications to take into account lessons learned by Virginia DOT. The NCRWQB uses Virginia DOT's earlier study to justify its restrictions on CIPP, not taking into account further developments in Virginia, and has made styrene effluent limits so low that using CIPP is impossible even with new installation practices. The NCRWQB is also requiring Caltrans to conduct a pilot study that would be cumbersome and impractical to perform.

Caltrans is interested in adopting a more scientific approach to the regulatory standards that will allow for continued use of CIPP. This Preliminary Investigation presents the results of a review of completed research and a survey of state practices addressing the use of CIPP in an environmentally safe manner. To gather information for this investigation, we:

- Conducted a literature search about the effects of CIPP on the environment, and responsible methods and practices for using CIPP with a focus on finding related studies by or on behalf of other state transportation agencies.

- Contacted Insituform Technologies, a CIPP manufacturer, regarding the environmental impacts of using CIPP.
- Performed a brief survey of members of the AASHTO Standing Committee on the Environment regarding DOT use of CIPP, asking whether they have faced water quality problems and how they have addressed them. After the survey, we conducted follow-up phone interviews with four of the participating DOTs: New York, Oregon, Virginia and Washington.

## **Summary of Findings**

Our literature review found no additional published research about the environmental effects of CIPP installations beyond the reports referred to in Caltrans' request. We distributed the following survey to members of the AASHTO Standing Committee on the Environment:

1. Does your agency use cured-in-place pipe (CIPP) repairs as a method for rehabilitating culverts?

If yes to #1:

2. Please provide copies of or links to specifications and guidance related to your agency's use of CIPP.
3. Have you encountered any problems with your use of CIPP related to its effects on water quality? Has a water quality regulatory agency challenged the use of CIPP by your agency?
4. If yes to #3, how did you respond to these problems and concerns? Did you modify CIPP specifications, or have you conducted studies related to CIPP effects on water quality? (If so, please provide relevant reports.)
5. Who at your agency may we contact for further information about this issue (email and phone)?

Staff at 14 state DOTs and the Canadian province of Alberta responded to this survey. (See **Survey and Interview Results** beginning on page 7 of this report for the full text of these survey responses.) We also conducted follow-up interviews with four states (New York, Oregon, Virginia and Washington). Arkansas State Highway and Transportation Department did not respond to email or phone inquiries.

The survey and follow-up interviews confirm the lack of research into the environmental effects of CIPP installations, although two states—New York and Oregon—noted that they had done some water quality testing of CIPP installations. Further, Virginia DOT completed some recent testing of a CIPP repair (using new specifications) that showed the installation to have no water quality issues.

While 11 of 15 respondents said they use CIPP, only four states reported water quality issues:

- **New York:** Shortly after Virginia DOT's original study, a New York State DOT regional office expressed concerns about styrene from CIPP installations and conducted testing that found levels far in excess of allowable limits. As a consequence, New York State DOT revised its specifications and is currently confident that installations can be done without negative environmental impacts.
- **Oregon:** Oregon DOT took water quality samples from a "bungled" CIPP installation and found 174 parts per million of styrene. The contractor in this case used steam instead of hot water for curing and failed to divert incoming water. There was styrene discharge into the Willamette River, and styrene levels were so high that the responder had to wear a respirator to collect samples. Oregon DOT hopes that this scenario is a rare exception, and specifications call for all wastewater to be contained.
- **Virginia:** Virginia DOT recently conducted water quality testing on a CIPP repair that complied with its new specifications, and found the installation to be very clean. Samples were collected at the outlet a few days following installation and about 10 meters downstream, with results showing styrene levels of 0.294 mg/L at the outlet and 1.34 mg/L downstream. These levels are below the toxicity thresholds for rainbow trout (a common indicator species). In August 2012 the

agency will release reports on water quality testing results for both ultraviolet (UV)-based CIPP repairs and polyuria and cementitious spray-on liners.

- **Washington:** Washington State DOT has used CIPP repairs only on two design-build projects, but does not have specifications for CIPP repairs. Both projects had water quality issues, leading to a violation and \$9,000 fine. As a consequence, the agency recommends that culverts be replaced rather than relined in most cases; when relining is used, water should be diverted around the pipe being relined.

Seven of the 11 respondents using CIPP provided specifications; Maryland and Washington noted that they do not have CIPP specifications.

## **Gaps in Findings**

- There is no published research available on the environmental impacts of CIPP repairs beyond the original report by the Virginia Transportation Research Council (VTRC). (See Understanding the Environmental Implications of Cured-in-Place Pipe Rehabilitation Technology in **Related Research and Guidance**.) Further, only Virginia DOT has conducted water quality testing on a carefully controlled CIPP installation to evaluate the effectiveness of more stringent specifications.
- A number of states are planning to provide CIPP specifications but were unable to provide them within the deadline for this Preliminary Investigation.
- We talked briefly to Chris Hanson of Insituform Technologies, who was not aware of any research on the environmental effects of CIPP repairs, but he is making inquiries internally.
- We were unable to reach an appropriate contact at the Arkansas State Highway and Transportation Department, which Caltrans had singled out as being of interest.
- We did not find studies comparing CIPP-related water quality data to applicable California standards, which is the information specifically requested by the NCRWQCB and SFRWQCB.

## **Next Steps**

Moving forward, we recommend that Caltrans:

- Contact Joe Sicluna of New York State DOT and Bridget Donaldson of Virginia DOT for water quality testing results of CIPP installations.
- Follow up with Bridget Donaldson of Virginia DOT for forthcoming reports on the water quality effects of repairs using UV-cured CIPP and spray-on liners.
- Follow up with Chris Hanson of Insituform Technologies on the results of internal inquiries about the environmental effects of CIPP repairs.
- Contact Robert Trevis of Oregon DOT for further information about the use of CIPP in that state.
- If necessary, conduct further studies on the water quality effects of CIPP installations.

## **Contacts**

During the course of this Preliminary Investigation, we spoke to or corresponded with the following individuals:

### **CIPP Vendor**

#### **Insituform Technologies**

Chris Hanson  
(916) 616-3920

### **State Agencies**

#### **New York**

Michael Mathioudakis  
New York State Department of Transportation  
(518) 457-9800, [mmathioudakis@dot.state.ny.us](mailto:mmathioudakis@dot.state.ny.us)

Joe Sicluna  
New York State Department of Transportation  
(607) 721-8479, [jsicluna@dot.state.ny.us](mailto:jsicluna@dot.state.ny.us)

#### **Oregon**

Ken Cannon  
Aquatic Biology Program Coordinator, Geo-Environmental Section  
Oregon Department of Transportation  
(503) 986-3518, [ken.h.cannon@odot.state.or.us](mailto:ken.h.cannon@odot.state.or.us)

William Fletcher  
Water Resources Program Coordinator, Geo-Environmental Section  
Oregon Department of Transportation  
(503) 986-3509, [william.b.fletcher@odot.state.or.us](mailto:william.b.fletcher@odot.state.or.us)

Robert Trevis  
Culvert Design Engineer  
Oregon Department of Transportation  
(503) 986-3860, [robert.e.trevis@odot.state.or.us](mailto:robert.e.trevis@odot.state.or.us)

Paul Wirfs  
Oregon Department of Transportation  
(503) 986-3526, [paul.r.wirfs@odot.state.or.us](mailto:paul.r.wirfs@odot.state.or.us)

#### **Virginia**

Bridget Donaldson  
Virginia Department of Transportation  
(434) 293-1922, [bridget.donaldson@vdot.virginia.gov](mailto:bridget.donaldson@vdot.virginia.gov)

#### **Washington**

Christina Martinez  
Washington State Department of Transportation  
Compliance Branch Manager, Environmental Services  
(360) 705-7448, [martich@wsdot.wa.gov](mailto:martich@wsdot.wa.gov)

## **Related Research and Guidance**

**“A Pilot Study for Retrospective Evaluation of Cured-in-Place Pipe (CIPP) Rehabilitation of Municipal Gravity Sewers,”** E. Allouche, S. Alam, J. Simicevic, R. Sterling, W. Condit, J. Matthews, A. Selvakumar, *Tunnelling and Underground Space Technology*, March 2012.

<http://www.sciencedirect.com/science/article/pii/S088677981200034X>

This paper presented results from a pilot project that tested CIPP liners for thickness, annular gap, ovality, density, specific gravity, porosity, flexural strength, flexural modulus, tensile strength, tensile modulus, surface hardness, glass transition temperature and Raman spectroscopy. Researchers also gathered environmental data, including external soil conditions and pH and internal waste stream pH. Samples retrieved from the four locations involved in the pilot study testing were in excellent condition after being in use for 25 years, 23 years, 21 years and 5 years, respectively. Overall, researchers concluded that there is no reason to anticipate that the liners evaluated in this pilot study will not last for their intended lifetime of 50 years and perhaps well beyond.

**Review of Styrene Water Quality Goals and Recommended Next Steps for CIPP Projects,** Brown and Caldwell, March 2012.

See [Appendix A](#).

This technical memorandum briefly summarizes water quality issues related to styrene in CIPP rehabilitation projects and recommends potential next steps for Caltrans to consider in response to recent regulatory developments related to styrene, including modifying CIPP specifications to reflect lessons learned from Virginia DOT.

**“State-of-the-Art Literature Review on In-Situ Pipe Repairs and Durability,”** Fazil Najafi, Brad Cooney, Adnan Javed, *TRB 90th Annual Meeting Compendium of Papers DVD*, Paper #11-1269, 2011.

Abstract available at <http://trid.trb.org/view/2011/C/1091856>

*From the abstract:* After an extensive literature review, it can be concluded that, when compared to the traditional open cut pipe replacement method, in-situ technologies cause less disruption to the surrounding environment, less inconvenience on the community, and in appropriate applications are more cost-effective.

**A Technical Review of VTRC’s Research Report: Understanding the Environmental Implications of Cured-in-Place Pipe Rehabilitation Technology,** Ed Campbell, 2010.

See [Appendix B](#)

This report reviews the 2008 report by the VTRC, *Understanding the Environmental Implications of Cured-in-Place Pipe Rehabilitation Technology*, and concludes that it was executed poorly “without practical scientific reasoning.” Criticisms cover the failure to evaluate curing methods other than steam (such as hot water and UV light), sampling methods and a lack of a cost-benefit analysis. The author concludes: “The VA DOT had a real opportunity to provide the industry with an independent review of its practices and refine them as needed to preserve their cost-effective (and environmentally-effective) usage. The report falls short on this and the conclusions reached were not based on sound engineering principles. The end result is a document that is misleading to the general public and of little use to the technical community without a lot of work to sort out the test results and what guidance they may provide.”

**“Creating Environmentally Sound Specifications for Culvert Rehabilitation: Virginia Applies Findings for Cured-in-Place Pipe Repair,”** Bridget Donaldson, Edward Wallingford, *TR News*, Issue 268, 2010: 47-49.

<http://onlinepubs.trb.org/onlinepubs/trnews/trnews268RPO.pdf>

This technical overview summarizes the VTRC’s evaluation of the impacts of styrene-based CIPP repair on water quality. VTRC’s findings led to the development of new construction specifications to minimize environmental risks and ensure maximum structural performance of the finished product. Specification

requirements are discussed as well as the benefits of more stringent controls of the installation process. Modified specifications require the following:

- Both an inner and an outer impervious film to envelop the resin-liner system and promote complete polymerization, prevent resin loss and prevent styrene contamination of the interior portion of the finished pipe.
- Use of a semirigid plastic slip sheet over significant voids and pipe intrusions that could damage the liner during insertion.
- Installation oversight by a trained inspector.
- Time-temperature monitoring, with data logging, at points throughout the length of the pipe for the curing of the lining material.
- Thorough rinsing of the finished product.
- Proper containment and disposal of effluent cure water and rinseate.
- Water and soil testing for styrene before and after installation.
- Corrective actions to remediate the accidental release of styrene.

**“Environmental Implications of Cured-in-Place Pipe Rehabilitation Technology,”** *Transportation Research Record*, Vol. 2123, 2009: 172-179.

Citation at <http://trid.trb.org/view/2009/C/880557>; see [Appendix C](#) for full report.

*From the abstract:* In this study, seven styrene-based, steam-cured CIPP installations in surface water and storm water conveyances in Virginia were identified and observed over the course of 1 year. Although the sites were not directly linked to sources of drinking water, styrene levels at five sites were higher than the Environmental Protection Agency’s maximum contaminant level for drinking water of 0.1 mg/L. These concentrations were detected at these sites for a minimum of 5 days to 71 days after installation. Certain measurements were also found to exceed the concentration required to kill 50% of several freshwater aquatic indicator species. The findings suggest that the elevated styrene levels could have resulted from one or a combination of the following: (a) installation practices that did not capture condensate containing styrene, (b) uncured resin that escaped from the liner during installation, (c) insufficient curing of the resin, and (d) some degree of permeability in the lining material. In response to the preliminary findings of this study, the Virginia Department of Transportation suspended the use of styrene CIPP for conveying surface or storm water while the department further evaluated CIPP repair and subsequently developed new requirements for these installations.

**Guideline for the Use and Handling of Styrenated Resins in Cured-in-Place Pipe**, NASSCO CIPP Committee, September 2008.

See [Appendix D](#).

This document presents a state-of-the-art guideline for the use and handling of styrene-based resins in the CIPP pipeline rehabilitation industry. Members of the committee conclude that CIPP installation sites managed with good housekeeping will present little opportunity for human health risks and/or environmental risks; and that studies done to date have concluded that CIPP resin systems do not appear to be a significant source of styrene or any of the other volatile organic compounds that are typically of concern in occupational or air quality studies. They also note that relevant studies show styrene biodegrades quickly in most environments.

**Understanding the Environmental Implications of Cured-in-Place Pipe Rehabilitation Technology**, Bridget Donaldson, Andrew Baker, Virginia Transportation Research Council, May 2008.

[http://www.virginiadot.org/vtrc/main/online\\_reports/pdf/08-r16.pdf](http://www.virginiadot.org/vtrc/main/online_reports/pdf/08-r16.pdf); or see [Appendix E](#).

*From the abstract:* To evaluate the potential for impacts on water quality from the steam-cured CIPP process, seven CIPP installations in surface water and stormwater conveyances were identified and observed over the course of a 1-year study in Virginia. Water samples were collected from each project site and analyzed for styrene. The results were then evaluated for compliance with established regulatory standards and published aquatic toxicity criteria. Water samples collected from pipe outlets at five of the seven CIPP installations showed detectable levels of styrene. Styrene concentrations were generally

highest in water samples collected during and shortly following installation. The maximum duration that styrene was detected at any site was 88 days following the CIPP installation. Although the sites in this study were not directly linked to sources of drinking water, styrene levels at five sites were higher than the U.S. Environmental Protection Agency's maximum contaminant level for drinking water of 0.1 mg/L. Styrene was detected at five sites for a minimum of 5 days to at least 71 days after installation and was detected at these sites up to 40 m downstream. Certain measurements were also found to exceed the values for EC50 (the concentration required to have a defined effect on 50 percent of a study population) or LC50 (the concentration required to kill 50 percent of a study population) for several freshwater aquatic indicator species. The findings suggest that the elevated styrene levels could have resulted from one or a combination of the following: (1) installation practices that did not capture condensate containing styrene, (2) uncured resin that escaped from the liner during installation, (3) insufficient curing of the resin, and (4) some degree of permeability in the lining material. A summary of the actions taken by the Virginia Department of Transportation (VDOT) in response to the preliminary findings of this study is also provided in this report. VDOT suspended the use of styrene-CIPP for pipes that convey surface or stormwater while further evaluating CIPP repair and subsequently developing new requirements for these installations. The new measures include substantial modifications to VDOT's CIPP specifications; an inspector training program; increased project oversight; and water and soil testing prior to and after CIPP installation. Reinstatement of statewide VDOT CIPP installations using the new procedures and specifications is planned for May 2008.

## **Survey and Interview Results**

The full text of each survey response is provided below. Some responses have received minor edits for clarity. For reference, we have included an abbreviated version of each question before the response; for the full question text, please see the **Summary of Findings** on page 2 of this report.

### **Alberta**

1. **Use of CIPP?** No.
2. **Specifications and guidance?** N/A.
3. **Water quality and regulatory problems?** N/A.
4. **Response to problems?** N/A.
5. **Staff contact information:** Des Williamson, Director, Bridge and Water Management Section, (780) 415-1015, [des.williamson@gov.ab.ca](mailto:des.williamson@gov.ab.ca).

### **Arizona**

1. **Use of CIPP?** Yes. We have contracts through our procurement office and know of a few projects that opted to perform this type of work. AZDOT is still working on its survey response and will provide more information, including specifications, in the last week of June.
2. **Specifications and guidance?** N/A.
3. **Water quality and regulatory problems?** N/A.
4. **Response to problems?** N/A.
5. **Staff contact information:** Leigh Waite, Water Quality Analyst, Office of Environmental Services, (602) 712-6170, [lwate@azdot.gov](mailto:lwate@azdot.gov).

## **Idaho**

1. **Use of CIPP?** Yes.
2. **Specifications and guidance?** Not provided (awaiting response from Construction Engineer).
3. **Water quality and regulatory problems?** Not aware of any issues.
4. **Response to problems?** N/A.
5. **Staff contact information:** Sue Sullivan, Environmental Program Manager, (208) 334-8203, [sue.sullivan@itd.idaho.gov](mailto:sue.sullivan@itd.idaho.gov).

## **Indiana**

1. **Use of CIPP?** Yes.
2. **Specifications and guidance?** See the Technical Advisory for Pipe Lining, 1202-ta.pdf ([Appendix F.1](#)). The CIPP liners feature in the latter half of the Technical Advisory. See also a unique special provision (USP) that Indiana used as a specification in the past, CIPP USP.pdf ([Appendix F.2](#)).
3. **Water quality and regulatory problems?** I don't believe we've run into any problems with CIPP related to water quality. I've heard potential concerns about thermal pollution downstream of the structure from the steam used in the CIPP curing process, but none of the water quality regulatory agencies have challenged our use of CIPP.
4. **Response to problems?** N/A.
5. **Staff contact information:** Crystal Weaver, Hydraulics Manager, (317) 233-2096, [cmweaver@indot.in.gov](mailto:cmweaver@indot.in.gov).

## **Maryland**

1. **Use of CIPP?** The Maryland State Highway Administration (SHA) has had very limited experience with these types of repairs.

**From the Highway Hydraulics Division:** We have used this in one or two instances under our time and materials contract several years ago. It was for a small diameter pipe for a storm drainage system—no stream, all dry system. No monitoring was done. Since this was time and materials contract, the work was prescribed in the field by SHA staff. We do not have specification.

**From the Structures Engineering Division:** We do not use this product for several reasons, cost being one of them. Highway Hydraulics has used this system since they have smaller pipes and it is more cost effective to use for certain applications: small pipes under large fills. I am familiar with the product, one being called Insitu-Form East, which has been around for a long time. It is typically used in smaller diameter pipes such as 18" diameter or 2' diameter sewers, etc. We have never used it on any of our small structures or culverts.

2. **Specifications and guidance?** None. (See above.)
3. **Water quality and regulatory problems?** Not aware of any issues. (See above.)
4. **Response to problems?** N/A.



5. **Staff contact information:** Bruce Grey, (410) 545-8500, [bgrey@sha.state.md.us](mailto:bgrey@sha.state.md.us).

## **New York**

*The following responses are based on phone conversations with Michael Mathioudakis and Joe Sicluna, interviewed at the suggestion of Bridget Donaldson of Virginia DOT.*

1. **Use of CIPP?** Yes.
2. **Specifications and guidance?** See [Appendix G.1](#) and [Appendix G.2](#).
3. **Water quality and regulatory problems?**

**Michael Mathioudakis (Albany central office):** New York has strict specifications for CIPP repairs, and since these specifications have been in place has not had any problems. It has done some informal, unscientific testing after implementation of these specifications and didn't find any problems. (See [Appendix G.3](#) for testing results.) New York only allows use of water curing, and never steam curing or UV. NYSDOT uses CIPP widely and is happy with its current CIPP specifications. [Note that this answer conflicts with that given by Joe Sicluna below.]

**Joe Sicluna (Binghamton regional office):** Our regional office expressed concerns about styrene from CIPP installations a few years ago. We tested styrene levels locally and found levels far in excess of allowable limits. (See [Appendix G.3](#) for water sampling results.) The discharge of hot water was itself also a violation of water quality standards (both styrene and hot water can affect trout and other species). Contractors were supposed to prevent this sort of discharge from happening, but they tended to cut corners and at the time no one took it seriously. As a consequence, NYSDOT revised its specifications to the effect that contractors had to be in compliance with all applicable water quality regulations, and no more discharge of wastewater to surface waters is allowed; everything must be caught in a truck and taken for treatment (although I know of no place where this kind of waste can be treated). As a result, contractors are opting to use non-styrene products, and I know of no CIPP contract since the new specifications. [Note that this answer conflicts with that given by Michael Mathioudakis above.] CIPP probably can be used cleanly if materials are contained, but that depends on the contractor's due diligence. UV or steam would produce less wastewater, but the central office is against their use.

4. **Response to problems?** NYSDOT responded to concerns from a regional office by changing specifications.

5. **Staff contact information:** Michael Mathioudakis, (518) 457-9800, [mmathioudakis@dot.state.ny.us](mailto:mmathioudakis@dot.state.ny.us);  
Joe Sicluna, (607) 721-8479, [jsicluna@dot.state.ny.us](mailto:jsicluna@dot.state.ny.us).

## **Ohio**

1. **Use of CIPP?** Yes—not used very often.
2. **Specifications and guidance?**  
[http://www.dot.state.oh.us/Divisions/ConstructionMgt/Specification%20Files/834\\_04162010%20for%202010.pdf](http://www.dot.state.oh.us/Divisions/ConstructionMgt/Specification%20Files/834_04162010%20for%202010.pdf)

**Submittals.** Submit a written installation plan for the conduit renewal to the Engineer for acceptance at least ten days before beginning work. Include the following information:

1. Design calculations and shop drawings for the renewed conduit. Ensure the calculations and shop drawings address the polymer physical properties and the lining thickness as shown in the plans.
2. Methods of cleaning the host pipe.
3. Plan to bypass flow around the host pipe.
4. Video survey of the host pipe before installation.
5. Site specific health and safety plan.

Install resin based liner materials in a dry host pipe. Prevent the accumulation and flow of water through the host pipe and liner until after the work is complete.

3. **Water quality and regulatory problems?** Not aware of any issues.
4. **Response to problems?** N/A.
5. **Staff contact information:** Ron Trivisonno, Construction Hydraulics Engineer, Office of Construction Administration, (614) 644-6588, [ron.trivisonno@dot.state.oh.us](mailto:ron.trivisonno@dot.state.oh.us).

## **Oregon**

*The following responses are based on a phone call with Paul Wirfs and email correspondence with Ken Cannon and William Fletcher.*

1. **Use of CIPP?** Yes.
2. **Specifications and guidance?** Our standard specifications and special provisions related to environmental protection are found here: <http://www.oregon.gov/ODOT/HWY/SPECS/index.shtml>; see Standard Specification, Section 00290 - Environmental Protection.

For unique circumstances we use 00290 "Special Provisions." These are specs that can be modified to meet site specific concerns. "Specials" are found here:

[http://www.oregon.gov/ODOT/HWY/SPECS/Pages/2008\\_special\\_provisions.aspx#Part\\_00200](http://www.oregon.gov/ODOT/HWY/SPECS/Pages/2008_special_provisions.aspx#Part_00200)

Also for specs related to CIPP, see Section 00410 - Pipe Lining, found here:

[http://www.oregon.gov/ODOT/HWY/SPECS/Pages/2008\\_special\\_provisions.aspx#Part\\_00400](http://www.oregon.gov/ODOT/HWY/SPECS/Pages/2008_special_provisions.aspx#Part_00400);

[http://www.oregon.gov/ODOT/HWY/SPECS/Pages/standard\\_specifications.aspx](http://www.oregon.gov/ODOT/HWY/SPECS/Pages/standard_specifications.aspx)

3. **Water quality and regulatory problems?**

**Paul Wirfs:** To his knowledge there are no problems with water quality due to CIPP. (See William Fletcher's response below for a conflicting answer.) Specifications require that a containment system be put in place.

**Ken Cannon:** Oregon fish passage laws limit our ability to use slip line technology on pipes in fish bearing streams. Slip line repair (in fish bearing streams) triggers a state law that requires us to meet fish passage standards at the site or mitigate off-site. Meeting the state fish passage standards usually means we have to replace the structure rather than repair it. My guess is that most (if not all) of our CIPP work is done on pipes that are not fish bearing, and therefore would not trigger fish passage laws. From the aquatic biology perspective, using the CIPP technology comes with concerns even in

non-fish bearing pipes. Chemical and heat contamination could be conveyed to areas where fish do reside. This kind of contamination could violate water quality standards and cause “take” of fish protected by the Endangered Species Act. For projects with these concerns, ODOT will direct contractors to protect natural resources through our Standard Specifications and Special Provisions.

**William Fletcher:** With regards to regulatory agency concerns, so far CIPP seems to have flown under the radar. According to one of our biologists who previously was the NMFS/ODOT liaison, the issue didn’t come up, but he assumed this was more due to lack of awareness that the epoxy might be an issue than real comfort with its use. I suspect that if NMFS were aware of the Virginia Transportation Research Center study on styrene releases from CIPP they might be less sanguine. As it is, CIPP is not mentioned one way or the other in the programmatic [Biological Opinion] NMFS is developing for use on highway projects in Oregon. Our HazMat Program Coordinator, Jennie Armstrong, has provided me with the sampling results from a bungled installation of a CIPP repair. See attached sampling results ([Appendix H.1](#) and [Appendix H.2](#)), which detected 174 parts per million of styrene. Jennie’s description of the event is: “It wasn’t really a spill in the traditional sense. The sub-sub-contractor was supposed to cure the pipe lining with hot water. Instead they used steam. This overheated the pipe lining such that it released more styrene (solvent) than it normally would and such that it melted the old asphalt lining in the original pipe. They also failed to divert all the incoming water so that water was able to flow between the old pipe and the new lining during installation. We also suspect they under-sized the lining, which further aided water in getting between the old pipe and the new lining. As a result the styrene laden water was able to dissolve the melted asphalt and wash it out into the Willamette River. The styrene levels were so high that our responder had to wear a respirator to collect samples.” As far as we are aware, this is the only characterization ODOT has done on water flowing through a CIPP pipe, and it was (we hope) a deplorable exception to what should normally happen. Jennie has advocated ODOT treating all cure water and steam from CIPP like any other waste stream, i.e., it must be contained and treated properly. Our specs in 00290 call for wastes to be contained, characterized and disposed of properly.

Robert Trevis has more information on CIPP use in Oregon, but will be unable to respond until after June 22.

4. **Response to problems?** N/A.
5. **Staff contact information:** Paul Wirfs, (503) 986-3526, [paul.r.wirfs@odot.state.or.us](mailto:paul.r.wirfs@odot.state.or.us); Ken Cannon, Aquatic Biology Program Coordinator, Geo-Environmental Section, (503) 986-3518, [ken.h.cannon@odot.state.or.us](mailto:ken.h.cannon@odot.state.or.us); William Fletcher, Water Resources Program Coordinator, Geo-Environmental Section, (503) 986-3509, [william.b.fletcher@odot.state.or.us](mailto:william.b.fletcher@odot.state.or.us); Robert Trevis, Culvert Design Engineer, (503) 986-3860, [robert.e.trevis@odot.state.or.us](mailto:robert.e.trevis@odot.state.or.us).

## **Pennsylvania**

1. **Use of CIPP?** Yes. We have tried CIPP in a few projects, but it is currently not on our approved products list. The District has requested individual project approvals to use this product. We have received a New Product application for this product. We are currently evaluating the product, but a decision has not been made.
2. **Specifications and guidance?** See [Appendix I](#).
3. **Water quality and regulatory problems?** None.
4. **Response to problems?** N/A.
5. **Staff contact information:** Sheri Little, Research Project Manager, (717) 787-3584, [slittle@pa.gov](mailto:slittle@pa.gov).

## **Tennessee**

1. **Use of CIPP?** No.
2. **Specifications and guidance?** N/A.
3. **Water quality and regulatory problems?** N/A.
4. **Response to problems?** N/A.
5. **Staff contact information:** Suzanne Herron, (615)741-2612, [suzanne.herron@tn.gov](mailto:suzanne.herron@tn.gov).

## **Utah**

1. **Use of CIPP?** Yes.
2. **Specifications and guidance?** See [Appendix J](#).
3. **Water quality and regulatory problems?** None.
4. **Response to problems?** N/A.
5. **Staff contact information:** Denis Stuhff, Hydraulics Engineer, [dstuhff@utah.gov](mailto:dstuhff@utah.gov).

## **Virginia**

1. **Use of CIPP?** Yes.
2. **Specifications and guidance?** <http://www.virginiadot.org/business/resources/const/cdmemo-0811.pdf>. See page 5, Method D.
3. **Water quality and regulatory problems?** Styrene-based CIPP was evaluated in 2007, prior to the pipe repair memorandum provided in the above link. The following report describes the monitoring results and the resulting actions taken by VDOT:  
[http://www.virginiadot.org/vtrc/main/online\\_reports/pdf/08-r16.pdf](http://www.virginiadot.org/vtrc/main/online_reports/pdf/08-r16.pdf).
4. **Response to problems?** Report and resulting specifications are provided above. We are also currently completing water quality studies on unconventional CIPP (including UV-CIPP and styrene-free CIPP) and spray-on liners.
5. **Staff contact information:** Bridget Donaldson, (434) 293-1922, [bridget.donaldson@vdot.virginia.gov](mailto:bridget.donaldson@vdot.virginia.gov).

**Follow-up phone call with Bridget Donaldson:** The new specifications for styrene-based CIPP are stringent enough to keep installations clean. Virginia conducted water quality on one installation and found it to be very clean. Samples were collected at the outlet a few days following installation, and about 10 meters downstream, with the following results for styrene levels:

- Outlet: 0.294 mg/L.
- Downstream: 1.34 mg/L.

These levels are below the toxicity thresholds for rainbow trout (a common indicator species).

Despite the fact that Virginia's specifications are working, it can be difficult to ensure a complete cure on all projects, which means that there is always the danger of uncured pockets of resin that leach into the water after installation.

Specifications have increased the costs and workload for contractors because they can't just release cure water downstream, but have to collect it and properly dispose of it at a wastewater facility; and they must hire an independent laboratory to do testing after installation. Consequently, the use of styrene-based CIPP in Virginia has become less common; epoxy-based and UV-based CIPP repairs are more common. Epoxy-based CIPP has its own water quality issues, and Virginia will also be tightening up its specifications for this method. UV-based CIPP seems to be cleaner than epoxy-based CIPP. In August 2012, VDOT will release reports on water quality testing results for both UV-based CIPP repairs and polyuria and cementitious spray-on liners (under the title "Water Quality Implications of Culvert Repair Options Available for Use by VDOT"; Caltrans recently accepted a spray-on liner into its list of approved products). The most popular method for repairing culverts other than CIPP involves steel liners (manufactured by DLB, Inc.). Before the use of CIPP and steel liners, Virginia used pneumatically applied concrete to patch holes, but such repairs did not last long, and there were concerns about raising the culvert's elevation and disrupting stream dynamics and aquatic passage.

Ms. Donaldson recommended talking to Joe Sicluna and Michael Mathioudakis of the New York State DOT, which conducted its own testing after Virginia's study. The agency found high styrene content after a few installations and developed specifications that are even more stringent than Virginia's. New York is the only other state that Ms. Donaldson knew of that was publically addressing CIPP installation water quality issues. She noted that many DOTs are probably reluctant to face the possibility that they might be engaged in environmentally damaging practices. However, she has also heard anecdotal evidence of other locales with CIPP-related water quality problems. Ontario has banned the use of CIPP repairs and the issue is now in litigation; there should be a ruling in January or February. Further, a California wastewater agency (Central Contra Costa Sanitary District, Martinez, CA) found that styrene from CIPP repairs damaged its systems.

## **Washington**

1. **Use of CIPP?** Yes—on two projects.
2. **Specifications and guidance?** WSDOT has only used CIPP repairs on two design-build projects (on Interstate 405). The contracts did not specify how to replace the culverts, only that they needed to be replaced. WSDOT does not have any contract specifications for CIPP repairs, nor have we developed any project specific/special provisions for CIPP repairs. WSDOT is not planning on developing specifications for CIPP repairs due to the lack of success we've had with that type of work. WSDOT does have specifications for other types of trenchless techniques. Contact Jay Christianson at (360) 750-7269 for more information.
3. **Water quality and regulatory problems?** Yes. WSDOT had problems on both I-405 projects (in 2009-2010 timeframe) during Cured in Place Pipe rehab. The first was on the Kirkland Nickel Stage 1 Project (in the old culvert that used to carry Forbes Creek under I-405). The second was on the South Bellevue Nickel Project (Trail Creek). In both cases, the water that came into contact with the curing chemicals was accidentally released downstream resulting in water quality issues. On the I-405 Bellevue Project, the Washington State Department of Ecology issued a \$9000 penalty to the contractor for the release of styrene into Trail Creek and failure to report. See our documented lessons learned and news items ([Appendix K](#)).
4. **Response to problems?** The following is in our lessons learned database:

RECOMMENDATION: Describe how the knowledge gained can be used.

The team recommends all stream bearing culverts to be replaced instead of relined in most cases. However, if relining is still considered for use we recommend all water be diverted around the pipe being relined. The diversions should be placed well above the work. In addition, the pipe should be fully blocked downstream of the work to prevent any accidental spills from reaching waters of the state. The pipe should be cleaned of all liquid compounds and inspected either manually or with a camera before water is allowed to flow through it. Lastly, contingency and communication procedures should be in place and strictly followed before and during work and should include all entities which may be impacted including downstream jurisdictions. Changes to the work plan in the field during work should only be considered upon consultation with the Project Engineer and Environmental staff. Environmental staff should be on-site or on-call during these operations.

5. **Staff contact information:** Christina Martinez, Compliance Branch Manager, Environmental Services,  
(360) 705-7448, [martich@wsdot.wa.gov](mailto:martich@wsdot.wa.gov).

**Follow-up phone call with Christina Martinez:** Christina confirmed that Washington State DOT has used CIPP on only two projects, and that these involved a discharge of styrene into a creek. The smell of the styrene was noticed by nearby residents, and there was significant political fallout, a written violation and a fine. The two instances of use of CIPP were for design-build jobs, for which Washington State DOT doesn't direct the contractor on methods and technologies. Washington State DOT is doing a lot of culvert repairs because it has many older culverts that are undersized for fish passage; these typically require new and larger culverts, and so Washington State DOT is not typically relining a lot of culverts. It does some relining for stormwater infrastructure.

### **Wisconsin**

1. **Use of CIPP?** No.
2. **Specifications and guidance?** N/A.
3. **Water quality and regulatory problems?** N/A.
4. **Response to problems?** N/A.
5. **Staff contact information:** Fred Wisner, Environmental Engineer, Environmental Services Section,  
(715) 499-5204, [frederick.wisner@dot.wi.gov](mailto:frederick.wisner@dot.wi.gov).

### **Wyoming**

1. **Use of CIPP?** No.
2. **Specifications and guidance?** N/A.
3. **Water quality and regulatory problems?** N/A.
4. **Response to problems?** N/A.
5. **Staff contact information:** Bill Wilson, Standard Plans Group, (307) 777-4216,  
[bill.wilson@wyo.gov](mailto:bill.wilson@wyo.gov).